

ABSTRACT

Farm expenditures for feed increased substantially between 1960 and 1969. Their proportion of total production expenses fluctuated between 17 and 21 percent. The importance of feed expenditures encourages a continuing farm interest in feed prices and regional price differences.

An explanatory model was developed. The Pesticide and General Farm Survey, 1966-67, was adopted as a means for obtaining the information necessary to apply the model. The purpose of the model was to explain different levels of prices paid for complete feeds, specified supplements, and shelled corn.

Variation in the independent variables of the model was associated with 16 to 54 percent of the total price variance, depending upon the product. The most consistent variables were protein content and bulk purchasing. Each added percentage of protein increased price from 3¢ to 20¢ per hundredweight. Bulk purchasing decreased price from 6¢ to 20¢ per cwt. Prior to the deductions of discounts, prices reported by respondents listing discounts, averaged higher than the prices reported by respondents not reporting discounts received. Large-scale operations reported lower prices than the smaller sized firms. The variation in average prices reported by source of purchase was sufficiently great so that no single source could be cited as always charging the lowest prices.

Keywords: complete feeds; supplements; soybean meal; shelled corn; dairy; beef; hogs; poultry; wholesale; retail noncooperatives; retail cooperatives; region; protein; fat; fiber; meal; pellets; crumbles; national brand; local brand; regional brand; price differences; region.

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HIGHLIGHTS

In a feed-price study based upon a model, among the more significant economic and statistical factors found were:

Large-scale operators, with \$1 million worth of livestock sales a year, generally paid lower average prices for feed than very small firms--77.5¢ a hundredweight (cwt.) when all other variables were held constant.

Feed protein content and quantity purchased were significantly associated with prices paid. For each percentage increase in protein, producers paid 3¢ to 20¢ more. For complete feeds, bulk purchases saved 6¢ to 72¢ a cwt.--an average of 33¢ over the cost of bagged feed. Bulk purchases of supplements averaged 37¢ less, and shelled corn, 25¢ less.

No single source of feed purchase (even wholesalers) always charged the lowest prices. For example, of 38 comparisons made, in 22 instances, the average prices of purchases from all wholesalers was less than those from retail cooperatives; 16 times, the reverse was true.

Point of purchase was also related to the level of prices. As might be expected, nearness to producer and producing regions tended to lower feed prices. An exception related to sampling procedure was found for respondents located along the Missouri River. Because many had ready access to barge ports, they reported lower average prices than respondents in the Corn Belt who lacked such access.

Although many farmers reported receiving discounts for feed, their higher reported base price offset the discounts.

Brand differences were significant only for complete dairy feeds. National dairy brands averaged 33¢ more a cwt. than local brands, other variables held equal.

PRICE DIFFERENTIALS FOR COMPLETE FEEDS, SUPPLEMENTS, AND SHELLLED CORN
A Regression Analysis

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INTRODUCTION

Farm expenditures for feeds rose from \$4.9 billion in 1960 to \$6.6 billion in 1969. During this period, feed expenditures represented more than 17 percent of total production expenses; for 8 of the 10 years they accounted for about 19 percent (table 1).

Table 1.--Total production and feed expenses, 1960-69 ^{1/}

Year	Total production expenses ^{2/}	Total feed expenses	Percent of total production expenses ^{2/}
	<u>Mil. dol.</u>	<u>Mil. dol.</u>	<u>Pct.</u>
1960	26,287	4,923	18.7
1961	26,976	5,121	19.0
1962	28,460	5,575	19.6
1963	29,519	6,128	20.8
1964	29,259	5,715	19.4
1965	30,681	5,749	18.6
1966	33,083	6,324	19.1
1967	34,478	6,472	18.8
1968	35,666	5,994	16.8
1969	38,064	6,634	17.4

^{1/}Reproduced from: U.S. Department of Agriculture. Economic Research Service. Farm Income Situation. FIS 216. July, 1970. pp. 56, 57, Cols. 1 and 19.

^{2/}Excluding Government payments to nonfarm landlords.

Farmers are aware of the substantial amounts they pay for feeds. They recognize prices paid affect farm income as directly as prices received. Thus, they wish an explanation for differentials within and between markets for the same or closely similar products.

This study examines the extent that price differences among regions were associated with specified product, service, market structure, (e.g., source of purchase) and market conduct attributes (e.g., bulk purchasing) as well as important exogenous factors. These variables were selected upon the basis of both market experience and economic theory as representing those most likely to explain such price differences.

THE SAMPLE

The USDA Pesticide Survey conducted in 1964 was repeated in 1966, with its scope broadened to include other farm inputs, such as feed and fertilizer. The model was developed before the start of the second Pesticide Survey. However, the sample used for the Survey also was used to collect the data needed for analysis using the model. Both the 1964 and 1966 samples were drawn with an emphasis upon the coverage of pesticide use. The universe sampled and the sampling rate in 1966, differed from those of the 1964 study. In 1966, all farms were sampled, but the larger farms were sampled at a higher rate. The sampling procedure is described in the appendix.

The total sampling procedure yielded 9,720 schedules, but far from all respondents reported purchases of any complete feeds, concentrates, supplements, and feed grains. Even so, several reported two or more.

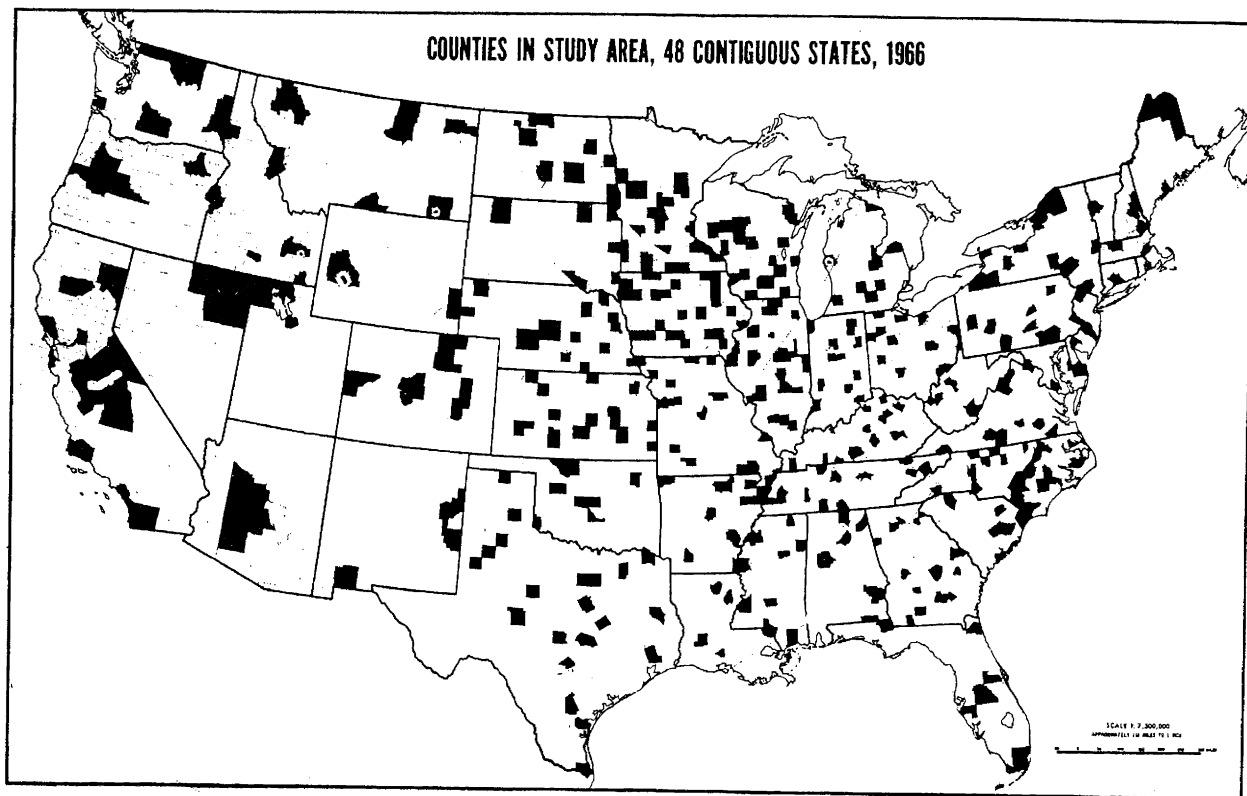


Figure 1

In many instances, there were too few schedules to warrant analysis: for peanut meal, urea, cottonseed meal, and all grains but shelled corn, there were only 100 or fewer schedules. Because of such fragmented purchase patterns, the total number of schedules returned was substantially greater than the number used for analysis. Specifically, the numbers of schedules used for analysis were: complete feeds 911; supplements 1,727; and shelled corn 503.

Figure 1 and table 2 present the geographic coverage by region and the proportion of the kinds of primary livestock feeding activity.

Table 2.--Distribution of schedules used for analysis, by region and respondent's primary livestock activity 1966-67

Region	Primary livestock activity			
	Dairy	Beef	Hogs	Poultry
	-----Percent-----			
Northeast	47.0	0.6	1.9	31.6
Appalachia	10.6	5.7	10.0	12.2
Southeast	1.8	6.3	2.4	6.1
Delta	9.0	6.3	1.0	0.0
Corn Belt	6.8	10.1	68.5	18.4
Lake States	7.9	0.6	4.3	9.2
Northern Plains	1.6	15.1	8.5	4.1
Southern Plains	4.3	30.2	1.9	5.1
Mountain	2.0	20.1	0.5	5.1
Pacific	9.0	5.0	1.0	8.2
Total	100.0	100.0	100.0	100.0

The Northeast accounted for 47 percent of all of the dairy schedules, and only Appalachia, the Delta, and the Pacific accounted for as many as 9 percent each. The Northern and Southern Plains and Mountain respondents whose primary activity was beef cattle dominated the sample; they accounted for 65.4 percent of all respondent schedules used. The Corn Belt dominated the responses by hog producers, accounting for 68.5 percent of all returns. Two areas, the Northeast and the Corn Belt accounted for 50 percent of all poultry farmer responses.

THE MODEL

A quantitative explanation of much of the differences among prices paid by farmers for feeds should be possible, provided the products are closely related or identical, and the time period is the same. The variables relevant to such an explanation range from product characteristics, services rendered as part of providing the product, market structure, and market conduct attributes, (e.g., kinds of stores from which purchases were made, and bulk purchases) to exogenous factors such as regionality. Regionality was a variable which represented all differences in average prices between regions not explicitly treated by an included variable, particularly those associated with transportation costs, climate, and local customs. Of course, many of these variables had to be used as "dummy variables" because they could not be cast otherwise. For example, feed can be sold in bulk or nonbulk. The dummy continuum is limited to 0-1.

Product characteristics included the protein, fat, and fiber content reported in numerical form, medication, crumbles, pellets, mixed, and meal all cast as dummy variables. All except fiber were expected to have positive signs for their regression coefficients. Fiber was assumed to have an inverse relationship with price, and thus was expected to have a negative regression coefficient.

Service variables included delivery, the point of delivery, and the provision of discounts. The services were expected to have positive signs as the more service, the more likely that price would increase. The discounted price (cited price minus discount) was expected to be below the nondiscounted prices.

Market structure variables were limited to the source of purchase, the size of farm firm making the purchase, and a proxy for the extent of competition within the

county where the respondent made his purchases. The sources of purchase ranged from retail noncooperatives, (all retail firms other than farm supply and service cooperatives) and cooperatives, to manufacturers. Prices usually were expected to be higher at retail than at the wholesale or manufacturing levels, but retail firms frequently provide more services to their purchasers than wholesalers and manufacturers.

Large farm firms were expected to pay less than small ones. In addition, higher index scores for weighted livestock nutritional units ^{1/} per acre were expected to be associated with higher numbers of competitors within the county where these respondents were located.

Market conduct variables included both buyers and sellers. Seller conduct items were limited to brands--national, regional, and local. For many products, other studies have shown that national-brand items tend to have higher prices that fluctuate less frequently than either regional or local brands. ^{2/} While there are no comparable studies for feeds, the greater costs that usually accompany the achievement of nationwide market penetration could result in a similar set of relationships.

Buyer conduct items were limited to the payment of cash, bulk purchasing, the numbers of purchases made during the year, the number of dealers contacted prior to the respondent's last purchase, and the number of dealers from whom respondent made purchases during the year.

These buyer practices could help explain price differences. The buyer who made many small purchases probably paid more than the buyer who bought the same quantity in fewer and larger lots. If the buyer asked prices of many dealers before buying, he should have determined if prices differed, and taken advantage of the lowest offer. Loyalty to dealers could also affect price.

Exogenous variables included period of purchase, regionality, and the farm price of corn. Period of purchase was included to determine if the secular trend has been sufficiently strong to exert a statistically significant impact during the study. Most of the price observations from last purchases reported were during the period November 1966 through March 1967. However, a substantial number fell between January, 1, 1966 and November, 1966. The farm price of corn was included in the analysis of complete feeds, because corn simultaneously is a competing feed, and a major ingredient for complete feeds.

^{1/}This index was computed by multiplying the number of each variety of animal and fowl per county by its respective nutritional coefficients which yielded a comparable set of animal units per county. These units in turn were divided by the number of acres per county to obtain an index of comparable nutritional units per acre. The higher this index, the greater the density of animal population within the county, and the higher the sales of feed. The higher the sales of feed per county, the higher was the probability that there would be more dealers available from which to purchase feed.

Because of the high intercorrelation between this variable and the regional dummy variables, it was eliminated in comparisons for complete feeds. It was eliminated from one model for the mixed supplement. It was used in lieu of regionality for shelled corn; and soybean meal, for one model. The nutritional units were taken from: Allen, George, and Devers, Margaret. National and State Livestock Feed Relationships, U.S. Dept. Agr. Statis. Bul. No. 446, 1970, table A, appendix, p. 84.

^{2/}National Commission on Food Marketing. Special Studies in Food Marketing--Private Label Products in Food Retailing. Tech. Study No. 10. U.S. Govt. Print. Off. June, 1966. Ch. 8 "Price Merchandising Practices and Sales." Nelson, Paul E. Jr. Pricing and the Food Retailer. Natl. Food Distrib. Res. Soc. Proc., Virginia Polytechnic Institute, Fall, 1968, Blacksburg, Va.

The model lent itself to regression analysis. The regression coefficients provided quantitative measures which showed the relationship of each variable to price. The use of stepwise regression also enabled the relative order of importance to be determined. Those variables which entered first had the least probability of having coefficients that were due to chance. However, it must be stressed that the regression coefficients reported are those computed after the last step had been computed. Since the F value for exclusion of a variable was 0.0001, this meant that the computation for the last step was essentially that of a standard least squares model.

The basic model was cast as follows:

$$x_0 = (f) \quad (x_1 \text{-----} x_{46}).$$

where x_0 served as the dependent variable--price per cwt. reported by the respondent for each feed, (or grain item) included in his last purchase, and $x_0 \text{-----} x_{46}$ the independent variables discussed above and summarized below:

- | | |
|---|---|
| 1. Weighted livestock nutritional units per acre | 23. Discount |
| 2. Value of livestock products sold in past year | 24. Cash |
| 3. Month of purchase Dec. '66-Mar. '67 | 25. Farmer delivery |
| 4. Region Northeast | 26. Dealer delivery |
| 5. Appalachia | 27. Custom hauler |
| 6. Southeast | 28. Delivered to storage bldgs. |
| 7. Delta | 29. Delivered to farmstead bulk feeders |
| 8. Corn Belt | 30. Delivered to field bulk feeders |
| 9. Lake States | 31. Distance hauled |
| 10. N. Plains | 32. Number of purchases |
| 11. S. Plains | 33. Number of dealers contacted |
| 12. Mountain | 34. Number of dealers from whom purchases were made |
| 13. Pacific | 35. Meal |
| 14. Bulk purchase | 36. Crumbles |
| 15. Retail noncooperative (All retail sources but farm supply and service cooperatives) | 37. Pellets |
| 16. Retail cooperative | 38. Mixed |
| 17. Wholesale noncooperative | 39. Medication |
| 18. Wholesale cooperative | 40. Protein |
| 19. Direct from manufacturer | 41. Fiber |
| 20. Farm-dealer | 42. Fat |
| 21. Buying-group | 43. Brand--regional |
| 22. Jobber-broker-contractor | 44. Brand--local |
| | 45. Brand--national |
| | 46. Farm price for corn |

CONTEXT

Distribution of Purchases by Source and Region

Complete feeds

Table 3 presents the context within which the regression analysis was conducted. Table 3 presents the proportion of the total number of most recent purchases by farmers reported by source and region. For each item, each row totals 100 percent. Thus, for complete feeds the Northeast accounted for 43.7 percent of its total purchases through retail noncooperative firms, 39.5 percent through retail cooperatives, 6.1 percent through wholesalers, 3.4 percent through farmer-dealers, and 7.3 percent direct from manufacturers.

Table 3.--Proportion of total number of purchases of complete feeds, supplements, and shelled corn, by source and region, 1966-67

Region	Complete feeds 1/					Total
	Retailer		Wholesalers, including jobbers and brokers	Farmer dealers and buying groups	Manu- facturers	
	Nonco- operatives	Coopera- tives				
-----Percent-----						
Northeast	43.7	39.5	6.1	3.4	7.3	100
Appalachia	60.0	27.4	6.3	2.1	4.2	100
Southeast	30.3	12.1	21.2	6.1	30.3	100
Delta	55.7	32.8	9.8	--	1.7	100
Corn Belt	64.2	22.9	3.0	2.6	7.3	100
Lake States	52.5	30.5	3.4	6.8	6.8	100
N. Plains	60.3	31.7	1.6	1.6	4.8	100
S. Plains	66.7	16.1	3.4	1.2	12.6	100
Mountain	60.3	11.1	3.2	1.6	23.8	100
Pacific	41.4	41.4	8.6	3.4	5.2	100
Supplements 2/						
Northeast	39.4	36.4	4.5	16.7	3.0	100
Appalachia	56.8	21.1	12.6	2.1	7.4	100
Southeast	32.5	15.0	20.0	22.5	10.0	100
Delta	55.6	14.8	3.7	3.7	22.2	100
Corn Belt	61.3	26.1	4.1	4.0	4.5	100
Lake States	51.9	34.3	4.2	7.1	2.5	100
N. Plains	55.3	35.0	2.6	3.0	4.1	100
S. Plains	58.1	17.7	17.7	--	6.5	100
Mountain	49.4	24.0	9.3	4.0	13.3	100
Pacific	50.0	12.5	--	--	37.5	100
Shelled corn						
Northeast	38.5	15.4	11.5	30.8	3.8	100
Appalachia	32.8	8.2	3.3	52.4	3.3	100
Southeast	--	11.1	33.3	55.6	--	100
Delta	16.6	16.7	50.0	16.7	--	100
Corn Belt	39.8	24.8	1.3	34.1	--	100
Lake States	37.8	35.1	1.4	25.7	--	100
N. Plains	52.0	30.6	2.7	14.7	--	100
S. Plains	11.1	22.2	33.4	33.3	--	100
Mountain	61.5	7.7	--	30.8	--	100
Pacific	25.0	50.0	25.0	--	--	100

^{1/}Complete feed - contains everything the animal needs in the ration (except may or may not contain processed hay and other roughage).

^{2/}Supplement - a formula feed which requires the addition of grain and sometimes protein to make a complete ration. Used at the rate of 100 pounds or more (usually more than 300 pounds) per ton of complete feed. In this study each had 24% or higher protein.

Respondents from Appalachia, the Corn Belt, the Northern and Southern Plains, and the Mountain Regions made 60 percent or more of their complete feed purchases through noncooperative retail stores. Those from the Southeast made the fewest--30.3 percent. Cooperatives were strongest in the Northeast, Delta, Lake States, Northern Plains, and the Pacific, where they sold at least 30 percent of all complete feeds. Only in the Southeast did purchases made through wholesalers reach 20 percent. The purchase of complete feeds directly from the manufacturer was 30.3 and 23.8 in the Southeast and Mountain regions.

Supplements

Table 3 also presents the source of purchase information for supplements by region. Respondents purchased supplements most frequently at retail. In the Southeast, Delta, and Mountain regions respondents also made purchases from farmer dealers, and directly from manufacturers. In the Southeast, respondents purchased 22.5 percent of their purchases from farmer dealers, and 10.0 percent from manufacturers. In contrast, the respondents in the Mountain region reported 9.3 percent from wholesalers, and 13.3 percent direct from manufacturers.

Some differences in source of purchase were evident between complete feeds and supplements. In Appalachia, about 27 percent of total purchases for complete feeds were made through cooperatives; about 21 percent went for supplements. In the Delta area, this differential was even more pronounced--33 percent for complete feeds and 15 percent for the supplements. The biggest differential of all was in the Pacific region, where the shift was from 41 percent for complete feeds to about 13 percent for supplements.

Inversely, some regions showed a rise in the proportion of purchases from cooperatives for supplements over the proportion of the total number of purchases for complete feeds made through cooperatives. Thus, in the Corn Belt, Lake States, and Northern Plains about 3 percent more purchases for supplements were made through cooperatives than purchases of complete feeds. The greatest differential was in the Mountain Region where 24 percent of the purchases of supplements were through cooperatives, and 11 percent of the complete feed purchases were made through them.

Shelled Corn

For shelled corn, the distribution of purchases was more even. Only in the Northern Plains, Mountain, and Pacific Regions were as many as 50 percent of the total purchases of shelled corn made at retail. In the Pacific these were primarily through cooperatives, in contrast to supplements where only about 13 percent of the purchases were made through cooperatives.

Wholesale sources and farmer-dealers accounted for at least 50 percent of total purchases of shelled corn in the Delta, Appalachia, and the Southeast. This contrasts sharply with the purchases of complete feeds and supplements, where well over 50 percent of all purchases were made at retail. The relationship of price differences to source of purchase will be one of the associations examined in the regression analysis.

Delivery and Purchase Patterns, and Product and Brand Attributes

Delivery

Dealer-manufacturers made more than 50 percent of all complete-feed deliveries, ranging from 50.3 to beef farms, to 82.4 percent for dairy farms. Farmers made their own deliveries for about 45 percent of all purchases reported by beef and hog operations. Only for poultry farms did custom haulers account for as much as 12 percent of total complete-feed deliveries.

Except for the mixed supplement, farmers made over 50 percent of all other deliveries. For the supplements and shelled corn, custom haulers accounted for 3 percent of all soybean meal deliveries, and 10 percent for shelled corn. The mixed fell between. For these items, farmers and dealer-manufacturers dominated, with farmers accounting for more than 50 percent, except for mixed supplements, where dealers accounted for 55 percent.

In terms of point of delivery, farm storage buildings predominated. They ranged from 57 percent of all complete-fee deliveries for poultry growers, to 92 percent for beef farms. Delivery to farmstead bulk feeders range from 8 percent for complete beef feeds to 39 percent for complete poultry feeds. Only for complete poultry feeds did deliveries to field bulk feeders account for as much as 4 percent.

Purchases

Bulk buying, as a percentage of all sales, ranged from 26.4 percent for complete beef feeds to 93.4 percent for shelled corn (table 4). Over 40 percent of sales for complete feeds for dairy and poultry were bulk. Five of the nine items were frequently discounted: complete feeds (dairy, hog, and poultry); soybean meal; and mixed supplement. Discounts were reported for 25 percent or more for each of these items.

Cash payments predominated over credit arrangements except for complete dairy feeds. Complete dairy feeds were lowest, with 46 percent of all sales for cash. For all other reported products, the lowest was 55 percent, and the highest, shelled corn, was about 75 percent.

The number of purchases made per year averaged 9.9 for complete beef feeds to 30.7 for poultry. The numbers of dealers contacted prior to their most recent purchase averaged highest for soybeans, 7.3, and ranged from an average of 1.3 to 2.0 for the remainder. The number of dealers from whom purchases were made during the 1966, and the number of dealers contacted prior to the last purchase both averaged about the same. The number contacted prior to purchase usually was slightly greater than the number from whom purchases were made.

Product attributes

Supplements, except for mixes, usually were in the form of meal. The supplement mixes were almost evenly divided between meal and pellets, with crumbles and mixed accounting for about 13 percent. The complete feeds were more varied in form than the supplements. For the complete feeds, poultry farmers reported 52 percent meal, and crumbles 25 percent. Pellets were first for hogs, with 65 percent, and meal was second with about 25 percent. Pellets dominated beef feeds, accounting for about 72 percent; mixed was a poor second, with approximately 20 percent. Complete dairy feeds had almost a trimodal distribution with meal and mixed falling between 20 and 37 percent.

Brand attributes

Brand was identified only for complete feeds. In dairy, regional brands dominated with about 46 percent, local brands accounted for 35 percent, and national brands for 19 percent. Beef differed: regional brands dropped to about 21 percent, local brands rose to almost 52 percent, and national rose to 27 percent. The distribution for hog producers was essentially trimodal. Regional brands had 34, local about 31, and national nearly 35 percent. For poultry regional and national brands accounted for 25 to 27 percent, but local dominated with 48 percent.

Table 4.--Delivery, purchase practices, product, and brand attributes, 1966-67

Item	Complete feeds				Supplements		Shelled corn
	Kinds				Soybeans	Mixed	
	Dairy	Beef	Hogs	Poultry			
-----Percent-----							
Delivery by:							
Farmer	15.6	46.5	45.2	16.3	52.4	41.7	53.2
Dealer-mfg.	82.4	50.3	52.4	71.4	44.6	54.7	36.8
Custom hauler	2.0	3.2	2.4	12.3	3.0	3.6	10.0
Delivery to:							
Farm storage bldgs.	83.3	91.8	70.4	57.1	87.5	84.7	83.1
Farmstead bulk feeder ...	15.5	8.2	26.7	38.8	11.9	13.8	15.5
Field bulk feeder	1.1	0.0	2.9	4.1	0.6	1.5	1.4
Product attributes:							
Meal	31.5	7.5	24.8	52.0	85.1	43.2	---
Crumbles	2.0	1.3	4.3	24.5	1.2	5.1	---
Pellets	37.0	71.7	64.7	14.3	10.7	44.0	---
Mixed	29.5	19.5	6.2	9.2	3.0	7.6	---
Brand:							
Regional	46.2	21.4	33.8	25.5	---	---	---
Local	34.9	51.6	31.4	48.0	---	---	---
National	18.9	27.0	34.8	26.5	---	---	---
Purchase attributes:							
Bulk buying	59.0	26.4	38.1	77.6	29.2	26.6	93.4
Discount recd.	42.3	15.1	41.4	34.7	25.0	40.3	4.4
Cash payment	45.7	68.6	60.0	58.2	69.0	65.3	74.4
No. of purchases made <u>1/</u> ...	25.9	9.9	22.7	30.7	15.0	18.7	13.6
No. dealers contacted <u>1/</u> ...	1.3	1.7	1.5	1.3	7.3	1.5	2.0
No. dealers from whom purchases were made <u>1/</u> ...	1.3	1.5	1.5	1.2	1.5	1.4	1.8

1/Figures are averages, not percentages.

AVERAGE REGIONAL PRICES BY KINDS OF FEEDS, AND U.S. AVERAGE BY SOURCE OF
PURCHASE AND FORM

Kinds

Complete Feeds

Table 5 presents the average price per hundredweight for complete feeds, by kind and as an aggregate for each region. As an aggregate, the complete feeds average price had a range of \$1.03. The Pacific reported \$3.71 and the Lake States \$4.74. The Corn Belt averaged 63¢ per cwt. higher than the Northern Plains consistently for each kind of complete feed. Many factors contributed to this, but among the more important was a sample-related one. A substantial proportion of respondents in the sample from the Northern Plains happened to come from counties that either were contiguous, or nearly so, with the Missouri River. The geographic distribution of respondents from the Corn Belt happened to fall so that the range was from southwest Missouri to eastern Ohio, and the number east of the Mississippi was at least as large as that from west of the Mississippi. The weighting of the Northern Plains sample along the Missouri River Basin contributed to the lower average prices for this region compared with the Corn Belt.

Table 5.--The average price per cwt. for complete feeds by region,
1966-67

Region	Complete feeds				Regional average
	Dairy	Beef	Hogs	Poultry	
	-----Dollars-----				
Northeast	3.97	3.85	4.42	4.19	4.11
Appalachia	3.95	3.53	4.75	4.39	4.16
Southeast	3.56	3.82	4.42	4.15	3.99
Delta	3.77	3.57	4.25	No rpts.	3.86
Corn Belt	4.12	3.82	5.01	3.97	4.23
Lake States	3.76	5.05	5.46	4.68	4.74
Northern Plains	3.23	3.66	4.10	3.41	3.60
Southern Plains	3.62	3.68	3.63	5.07	4.00
Mountain	3.67	3.73	4.25	3.24	3.72
Pacific	3.43	3.54	4.25	3.61	3.71
U.S. average	3.86	3.70	4.85	4.13	---

Important differentials were found among average prices by region, and they differed by specific feeds. Thus, the greatest regional differential for dairy feeds was 89 cents. The low mean price of \$3.23 was reported by the Northern Plains, and the high, \$4.12, by the Corn Belt. In beef feeds, the greatest regional differential was \$1.52; the low price (\$3.53) was reported by Appalachia, and the high (\$5.05), by the Lake States. Hog feeds differed by a maximum of \$1.83: the low mean price was associated with Southern Plains, and the high, \$5.46, with the Lake States. Poultry feeds had their highest mean price, \$5.07, in the Mountain Region, and their lowest regional average price in the Southern Plains. This differential of \$1.83 matched the difference found for hog feeds, both being greater than differences found for dairy, 89¢, and beef, \$1.52.

Part of the differences in aggregate averages reflect differences in the scale of operations in each region. We know that many large feeding operations were included in the samples from the Northern Plains, Mountain, and Pacific Regions. Smaller operations predominated in Appalachia and the Northeast. The somewhat smaller price range for complete hog feeds partially reflects a narrower range of scale available

for commercial hog operations than for commercial beef feeding lots. It is possible that the higher average for the Corn Belt reflected a higher proportion of medicated, or more heavily medicated, feeds that are associated with that region's larger scale hog operations than for the relatively smaller scale hog operations in other regions. Some of the differences also reflected a variation in the proportion of total sales within each region which were made by specific sources. Thus, in regions with large-scale operations predominating there may have been a higher proportion of bulk sales, and of purchases made through sources other than retail. Furthermore, since these averages included prices reported prior to deductions of discounts received, they must be higher than if they had been computed from the net--that is, discounted prices. Averages reflecting bagged purchases were probably affected more than those dominated by bulk, as proportionately, there were more of them.

Supplements and Shelled Corn

Table 6 presents the aggregate average price per cwt. for supplements and shelled corn. For soybean meal, the average price ranged from \$4.99 in the Northeast to \$5.96 in the Southeast. In the case of the mixed supplements with 24-percent protein or more, the range was from \$4.61 in the Southern Plains to \$5.81 in the Corn Belt. The same general reasons for price differences apply to these as well as to the complete feeds.

Table 6.--The average price per cwt. for supplements and shelled corn by region, 1966-67

Region	Supplements		Regional average	Shelled corn
	Soybean meal	Mix		
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The price for shelled corn ranged from \$2.16 per cwt. in the Northeast to \$3.18 in the Pacific region. The summer and fall of 1966 were periods of extreme drought in the Northeast. The price for the Northeast reflected both the poor quality of the 1966 crop and drought relief sales of Government stocks. Thus, the prices reported for the Northeast happen to represent a unique regional situation.

Source of Purchase

Table 7 reports U.S. averages by source of purchase for complete feeds. In aggregate, bulk purchases from all sources averaged \$3.84 per cwt. This average was below that of other purchases, which included some bagged. This difference also reflects the varying scales of operation reflected in the sample and the averages presented in tables 4 and 5. All wholesale purchases averaged \$4 and all retail \$4.11 per cwt. Retail cooperatives averaged 20 cents per cwt. less than retail nonco-

operatives, but the reported data did not include any comparisons of services rendered customers by each kind of retail outlet.

Table 7.--Average price per cwt. for complete feeds, by source of purchase, 1966-67

Source of purchase	Complete feeds				Source, average
	Dairy	Beef	Hogs	Poultry	
	-----Dollars-----				
Retail noncooperatives	3.92	3.71	4.95	4.25	4.21
Retail cooperatives	3.83	3.66	4.27	4.28	4.01
All retail	3.88	3.69	4.61	4.27	4.11
All wholesale	3.71	3.66	<u>1</u> /5.27	3.92	<u>2</u> /4.00
Bulk purchases-all sources ..	3.69	3.41	4.23	4.03	3.84

1/Includes \$8.40 from 1 buying group and 21 purchases from farmer dealers or manufacturers, which averaged \$5.34 per cwt. Wholesale cooperatives combined with wholesale noncooperatives equaled \$4.72.

2/Includes only wholesale cooperatives and noncooperatives.

The mean price of all bulk purchases was 23 cents per cwt. less than the price reported as the mean for dairy feeds purchased through retail noncooperatives. This difference is partly because bulk purchases were made from all sources (including wholesale), while the retail noncooperatives outlets included numerous small independents. The small scale of numerous retail noncooperatives may partially explain the difference in mean prices per cwt. of 9 cents. However, the study had no direct coverage of this point. Table 3 suggests that the locations of the greatest number of the retail farm supply cooperatives was in regions where large-scale farm operations were predominant in the sample.

The same kinds of explanations help us understand the 31¢ difference in price between bulk purchases, all sources, and purchases made only through retail noncooperatives. They also apply to the difference of 5 cents per cwt. between retail noncooperatives, and retail farm supply cooperatives. Bulk purchases for hog and poultry feeds also were lowest. However, one difference was found: for poultry feeds, the average price of purchases made through retail noncooperatives was 3 cents per cwt. less than those made through retail farm supply cooperatives. The data provide no obvious explanation.

Table 8 reports the average price per cwt. for supplements and shelled corn by source of purchase. Here also, except for shelled corn, the average price of bulk purchases from all sources was lowest. The retail cooperatives averaged 1¢ per cwt. higher than the noncooperatives for soybean meal, but 37¢ lower for mixed supplements of 24-percent protein or more. The distribution of the percent protein of all purchases by source was not known. It could have affected these averages. In the case of shelled corn, the retail cooperatives averaged 6 cents less per cwt. than the retail noncooperatives.

Table 8.--Average price per cwt. for supplements and shelled corn by source of purchase, 1966-67

Source of purchase	Supplements		Supplement	
	Soybean	Mix	source average	Shelled corn
	-----Dollars-----			
Retail noncooperatives	5.31	5.69	5.50	2.34
Retail cooperatives	5.32	5.32	5.32	2.28
All retail	5.31	5.51	5.41	2.31
All wholesale	4.80	5.56	5.18	2.26
Bulk purchase-all sources ..	4.96	5.29	5.13	2.27

Forms

Table 9 presents complete feed mean price comparisons by form. The prices are aggregate averages, which include all sources of purchase, all protein levels, and all regions. The 52¢ per cwt. differential between mixed form and crumbles for dairy feeds is partly associated with the cost differences in the feed preparation in other forms than meal. For beef feeds the \$1.30 range was associated with the difference between meal and crumbles. For hog feeds, the difference between meal and crumbles was \$1.19. For poultry, the greatest difference--29¢--was between meal and crumbles. The absolute price of crumbles tended to be higher than for other forms of mixed feeds. However, these differences include more than differences in form only. More precise insights with respect to form differences, all other variables held constant, will be provided by the regression analysis. Here, the differences are those without all other variables being held constant.

Table 9.--Average price per cwt. of complete feeds by kind and form of feed, 1966-67

Kind of complete feed	Meal	Crumbles	Pellets	Mixed
	-----Dollars-----			
Dairy	3.86	4.31	3.88	3.79
Beef	3.20	4.50	3.82	3.44
Hogs	4.38	5.57	5.03	4.43
Poultry	4.06	4.34	4.10	4.05

THE MODEL IN APPLICATION

Behind the aggregate average prices reported in tables 5-9 are the much more variable prices reported by each respondent. The regressions tested associations which were expected to help explain individual price levels which are not revealed by the comparisons in these tables.

The basic model, with some slight modifications where appropriate, was used to analyze differences among prices reported for each kind of feed. Because of the degrees of freedom requirement associated with the use of dummy variables, one dummy from each category was chosen to serve as the base for comparison for each of the other dummy variables composing the category.

For example, there were 10 regions, each in the form a dummy variable. Of these 10, one region served as base. In this sense it was deleted from the computation. Thus, for dairy feeds, the Northeast was selected as the base. Each of the other regions was compared with it. For beef, hog, and poultry feeds the Corn Belt served as the base. Hence, the regression coefficient for each region will reflect that region's price difference in terms of the amount that is greater than or less than the price of the base region, with all the other variables being held constant. The dummy base variables used for the price analyses conducted for complete feeds are presented below:

Complete feeds for--	Dummy variable base for--					
	Region	Source of Purchase	Point of delivery	Brand	Form offered	Agent of delivery
Dairy	NE	Retail cooperative	Field bulk feeder	Local	Mixed	Custom haul
Beef	Corn Belt	do.	do.	do.	do.	do.
Hogs	do.	do.	do.	do.	do.	do.
Poultry	do.	do.	do.	do.	do.	do.

A stepwise regression procedure was used to obtain the order in which each variable entered the computation process. However, because the F value for exclusion was set at 0.0001, when the final step was entered, all variables except those used as a dummy base variable, and variable 1 ³/₄ for the complete feeds and mixed supplement, were included. In essence, the final computation which furnished the regression coefficients reported in tables 12-18 was a full, standard least squares multiple regression analysis.

However, the initial use of the stepwise approach contributed valuable information. High and relatively high intercorrelations among several of the independent variables was found, and the stepwise procedure helped in the interpretation of how these variables interrelated. For instance, several variables which initially entered with statistical significance quite early in the stepwise procedure were no longer statistically significant by the time the final computation had been made.

This information enabled us to develop a second model which used only those variables that had had statistical significance either upon initial entry or after the final computation, or both. Because overall, the coefficients of regression in the complete and truncated models were very similar, we have limited our discussion of the truncated model to that which follows the analysis of the basic model.

Tables 10-16 report coefficients of simple correlation, multiple regression, and the standard errors of estimate ⁴/₄ of the regression coefficients, and their T values. In this study, a 10-percent level of statistical significance was chosen for the re-

³/₄See footnote 1.

⁴/₄A clear, succinct discussion of the concept of the standard error of the estimate for regression coefficients is presented in: Ezekiel, M. and Fox, K.A. Methods of Regression and Correlation Analysis, John Wiley & Sons Inc., London, 3d edition, 1966. p. 281.

gression coefficients. All regression coefficients with a T value of 1.64 ^{5/} or above are discussed in the text. The customary 5-percent level of significance was used to test the coefficients of correlation.

Price Difference Analysis--Complete Feeds

Dairy

Several variables had particular statistical significance. Of these, three related to product form, two to market structure, two to market conduct, and three to exogenous factors.

The product form variables were: protein, fat, and pellets. Each percent of protein added, raised price on the average by 8¢ per cwt., all other variables being held constant. The standard error (SE) of this regression coefficient was 2¢. Each additional percentage of fat (energy ingredients) average 9¢ (SE 4¢) more per cwt. Complete dairy feeds sold in pellet form average 17¢ (SE 8¢) more than the mixed form, when other variables were held constant.

The market structure variables of note were size of the farm purchaser, and the jobber-broker-contractor as the source of purchase. The size of the farm operation was measured in terms of each purchaser's total value of livestock product sales made during the preceding year. Because of the tremendous range, and the size of the largest farm firms reporting, the regression coefficient for size of purchaser was scaled to the respondent whose livestock product sales equaled \$1 million. When the regression coefficient had a negative sign, this particular coefficient reported the number of cents per cwt. by which the prices paid by farm operations of this size were less than the smallest sized ones, all other variables being held constant. For complete dairy feeds this equaled 21¢ (SE 10¢) per cwt. Purchases reported as being made through jobber-broker-contractors average 74¢ (SE 45¢) per cwt. less than those reported made through retail cooperatives.

Market conduct variables of statistical significance were bulk buying and national brands. Bulk purchases average 29¢ per cwt. (SE 7¢) less than bagged purchases. National brands averaged 33¢ (SE 9¢) more than local brands. This study had no data which reported the extent and quality of services provided by the sources of purchase.

Exogenous variables were limited to regionality. The Corn Belt averaged 27¢ per cwt. (SE 15¢) more than the Northeast, the Northern Plains 56¢ (SE 25¢) less than the Northeast, and the Pacific 28¢ (SE 12¢) less. To test for regionality, the basic model was rerun without all 10 regional variables. The different R^2 's were compared and tested to determine if regionality in total was statistically significant. It was for complete dairy feeds, but not for the other complete feeds.

Factors contributing to an explanation of these results included the difference in scale of dairy operations in the Corn Belt with the sample (30 respondents) possibly reflecting smaller operations, compared with many of the 209 respondents in the Northeast and the Northern Plains weighting of respondents along the Missouri River.

The price variation associated with the variation in the independent variables in the model (including all variables which made a positive contribution, whether they were or were not statistically significant) was 29 percent of total price variation.

^{5/}Persons wishing to limit their consideration to the customary 5-percent level of statistical significance should consider only those regression coefficients with T values of ≥ 1.96 .

Table 10.--Regression and simple correlation results for complete feeds--dairy

Independent Variables	Coefficients for computations			
	Simple r	Regression	Standard error	T value
Weighted livestock nutritional units per acre		ELIMINATED		
Value of livestock products sold in past year	-0.07	<u>1</u> /-0.21	<u>1</u> /0.10	1.99*
Month of purchase Dec. '66-Mar. '67 .....	.12	.14	.14	.99
Northeast		DUMMY BASE		
Appalachia .....	.05	- .07	.11	- .63
Southeast	- .06	- .31	.24	-1.27
Delta	- .04	- .19	.12	-1.62
Corn Belt .....	.11	.27	.15	1.80*
Lake States	- .04	- .11	.14	- .77
N. Plains	- .12	- .56	.25	-2.23*
S. Plains	- .08	- .09	.16	- .59
Mountain	- .04	- .28	.21	-1.31
Pacific	- .21	- .28	.12	-2.43*
Bulk Purchase	- .26	- .29	.07	-4.13*
Retail noncooperative .....	.09	- .04	.07	- .58
Retail cooperative		DUMMY BASE		
Wholesale noncooperative	- .03	- .10	.19	- .54
Wholesale cooperative	- .08	- .20	.20	-1.03
Direct from manufacturer	- .07	- .18	.14	-1.27
Farmer-dealer .....	.01	- .02	.16	- .11
Buying-group	<u>2</u> /	<u>2</u> /	<u>2</u> /	<u>2</u> /
Jobber-broker-contractor	- .02	- .74	.45	-1.65*
Discount .....	.02	- .03	.06	- .46
Cash	- .01	- .09	.06	-1.42
Farmer delivery .....	.08	.09	.21	.41
Dealer delivery	- .06	.04	.20	.20
Custom hauler		DUMMY BASE		
Delivered to storage buildings ..	.12	.16	.28	.56
Delivered to farmstead bulk feeders	- .09	.14	.28	.49
Delivered to field bulk feeders ..		DUMMY BASE		
Distance hauled	- .05	- .00	.00	- .58
Number of purchases .....	.00	- .00	.00	- .27
Number of dealers contacted	- .05	- .04	.03	-1.09
Number of dealers from whom purchases were made .....	.07	.04	.05	.75
Meal .....	.01	.11	.07	1.44
Crumbles .....	.10	.32	.20	1.57
Pellets .....	.02	.17	.08	2.15*
Mixed		DUMMY BASE		
Medication	<u>2</u> /	<u>2</u> /	<u>2</u> /	<u>2</u> /
Protein .....	.32	.08	.02	5.01*
Fiber .....	.00	.01	.01	1.10
Fat .....	.15	.09	.04	2.40*
Brand-Regional .....	.01	.06	.07	.89
Brand-Local		DUMMY BASE		
Brand-National .....	.19	.33	.09	3.73*
Farm price for corn .....	.11	.18	.28	.66

1/Scaled to farm firms with sales of \$1 million of livestock products during the preceding year.

2/No responses.

*Statistically significant.

The R was statistically significant at the 5-percent level. In addition, each independent variable was correlated with the dependent variable. Protein with an $r=0.32$, and bulk purchase with an $r=-0.26$ had the two highest simple correlation coefficients.

Beef

Six variables had particular significance. Three were product characteristic variables, one a service variable, a market structure, and a market conduct variable. None of the exogenous variables were statistically significant. The test for overall regionality also was not significant.

The product characteristic variables were protein, fiber, and crumbles. Protein averaged 7¢ (SE 2¢) per cwt. more for each percentage of protein added. Fiber was inversely related. For each additional percentage of fiber, the average price per cwt. dropped 3¢ (SE 2¢). Crumbles averaged 95¢ (SE 56¢) per cwt. more than the mixed form. Here the small number of responses for crumbles may have contributed to its large SE of 56¢.

Prices where dealers made deliveries averaged 64¢ (SE 37¢) per cwt. less than where the complete beef feeds were custom-hauled. While not quite statistically significant, the average prices reported for cases where farmers hauled their own feed also were 58¢ (SE 37¢) per cwt. less than custom-hauled.

The market structure variable, purchase from farmer-dealer, was statistically significant. Purchases from such dealers averaged 76¢ (SE 38¢) per cwt. more than purchases made from retail cooperatives. Here also the relatively small number of purchases from farmer-dealers may have contributed to the large standard error.

Bulk purchase was the conduct item of statistical significance. Bulk purchases averaged 26¢ (SE 14¢) per cwt. less than bagged. This appeared consistent with the regression coefficient found above for complete dairy feeds (29¢).

The price variation for the complete beef feeds associated with that in the independent variables was 34.9 percent of total price variation. The R was statistically significant at the 5-percent level. Simple r 's of note were: protein, 0.39; fiber, -0.20; delivery to farmstead bulk feeders, -0.23; delivery to farmstead buildings, 0.21; bulk purchase, -0.24; meal, -0.20, and pellets, 0.24.

Hog

Statistically significant variables for complete hog feeds included: protein, a product characteristic; buying group and size of farm purchaser, structural variables; number of purchases made during the year, and bulk purchases, both conduct variables, and the farm price of corn, an exogenous variable (table 14).

The addition of each percent of protein was associated with a price increase that averaged 17¢ (SE 4¢). The purchases reported by the farm purchaser with \$1 million of sales of livestock products averaged 39¢ (SE 23¢) per cwt. more than the smallest operation. This higher average price apparently reflected the purchase of higher

Table 11.--Regression and simple correlation results for complete feeds--beef

Independent Variables	Coefficients for computations			
	Simple r	Regression	Standard error	T value
Weighted livestock nutritional units per acre		ELIMINATED		
Value of livestock products sold in past year	-0.05	<u>1</u> /-0.07	<u>1</u> /0.05	-0.74
Month of purchase Dec. '66-				
Mar. '67	- .07	- .02	.16	- .12
Northeast .....	.02	.63	.94	.67
Appalachia	- .06	- .09	.35	- .26
Southeast .....	.05	.06	.37	.16
Delta	- .05	- .38	.33	-1.13
Corn Belt		DUMMY BASE		
Lake States .....	.15	1.00	.75	1.32
N. Plains	- .02	- .29	.25	-1.17
S. Plains	- .02	- .31	.27	-1.16
Mountain .....	.02	- .17	.29	- .57
Pacific	- .05	- .20	.40	- .51
Bulk purchase	- .24	- .26	.14	-1.84*
Retail noncooperative .....	.04	.11	.16	.70
Retail cooperative		DUMMY BASE		
Wholesale noncooperative	- .09	- .01	.44	- .03
Wholesale cooperative	- .01	.25	.44	.57
Direct from manufacturer	- .09	- .23	.28	- .80
Farmer-dealer .....	.15	.76	.38	1.98*
Buying-group		DID NOT ENTER <u>2</u> /		
Jobber-broker-contractor .....	.01	.21	.74	.28
Discount	- .03	- .19	.18	-1.03
Cash .....	.07	.00	.14	.03
Farmer delivery .....	.06	- .58	.37	-1.59
Dealer delivery	- .12	- .64	.37	-1.74*
Custom hauler .....	.16	DUMMY BASE		
Delivered to sotrage buildings ..	.21	.10	.71	.14
Delivered to farmstead bulk feeders	- .23	- .01	.75	- .02
Delivered to field bulk feeders ..		DUMMY BASE		
Distance hauled	- .04	- .00	.00	- .81
Number of purchases	- .10	.00	.01	.62
Number of dealers contacted .....	.07	.00	.05	.09
Number of dealers from whom purchases were made	- .02	.02	.07	.33
Meal	- .20	- .08	.26	- .32
Crumbles .....	.13	.95	.56	1.69*
Pellets .....	.24	.11	.20	.55
Mixed		DUMMY BASE		
Medication	- .00	-1.10	.81	-1.37
Protein .....	.39	.07	.02	3.22*
Fiber	- .19	- .03	.02	-1.68*
Fat .....	.00	- .05	.07	- .66
Brand-regional	- .01	- .14	.15	- .93
Brand-local		DUMMY BASE		
Brand-national .....	.08	- .06	.16	- .40
Farm price of corn	- .05	- .19	.93	- .21

1/Scaled to farm firms with sales of \$1 million of livestock products during the preceding year.

2/No responses.

*Statistically significant.

potency feeds by the larger operations. ^{6/} Purchases reported through the buying group averaged \$3.69 (SE 1.21) more per cwt. than purchases made through retail co-operatives. This figure must be interpreted in the context that for complete hog feeds only one buying group was reported. The price reported for this buying group was higher than each of the 44 prices reported for purchases made through retail co-operatives. Even so the singularity of this buying group suggests that it may not adequately represent all complete hog feed buying groups. Its appearance as 1 of 217 responses for complete hog feeds indicates the relative number of purchases made through this, compared with other sources.

The price variation associated with that in all variables was 47.5 percent of total price variation. The r's of note were: protein, 0.48; meal, -0.20; delivery to farm storage buildings, 0.27; delivery to farmstead bulk feeders, -0.26; discount, 0.23; bulk purchase, -0.42; and value of sales of livestock products by purchaser, 0.20.

Poultry

Two items were statistically significant: protein, a product variable, and the Lake States, an exogenous one. Each added percent of protein increased the average price per cwt. by 20¢ (SE 5¢). The purchase of complete poultry feeds reported by the Lake States averaged 66¢ (SE 40¢) per cwt. more than those reported in the Corn Belt. Table 1 shows that the Lake States accounted for 9.2 percent of the total sample of complete poultry feeds, and the Corn Belt for 18.4 percent.

In contrast to other complete feeds, the average prices reported for bulk purchases did not differ with statistical significance from the average reported for bagged purchases. Bulk purchases averaged 6¢ (SE 32¢) per cwt. less than bagged. This lower average was consistent with the results for the other complete feeds. Bulk purchases accounted for 78 percent of all responses for complete poultry feeds. It appears that the purchases for the bagged had less variance than those for the bulk.

Fifty-four percent of total price variation was associated with that for by all variables, and was statistically significant at the 5-percent level. However, because of the numbers of variables in relationship to the numbers of observations for complete poultry feeds, the R^2 may be biased upward. To estimate the maximum amount of such a bias, a second computation of R^2 was made. In this computation, only the two variables statistically significant in the above final computation, and the six variables with statistical significance upon initial entry, but without it in the final computation, were included. These variables were protein, farmer delivery, the value of sales of livestock products made by purchasers for the preceding year, Mountain Region, Northern Plains, date of purchase, medication, and the Lake States. The variation in these eight was associated with 47 percent of the total price variation, in contrast to the 54.5 percent for the 46 independent variables in table 13. Thus, the upward bias of R^2 injected by including all variables, given the number of total observations, did not exceed 7 percent.

The r's of note included: protein, 0.46; farmer delivery, 0.30; dealer delivery, 0.20; bulk purchase, -0.26; Mountain, -0.22; S. Plains, 0.23; and value of livestock

^{6/}The schedules for complete hog feeds were consistent in the larger operations reporting higher average prices. However, the medication block often was not checked. Because these schedules appeared accurate in all other respects, and their prices were not out of line with those from the same locality which did and did not report medication, no edit was made of the price or medication response. The almost significant T value for medication might have become significant if the medication block had been edited according to price level. There also is the possibility that due to chance, this sign is incorrect. In models of this size, a small number of incorrect regression signs can occur due to chance.

Table 12.--Regression and simple correlation results for complete feeds--hogs

Independent Variables	Coefficients for computations			
	Simple r	Regression	Standard error	T value
Weighted livestock nutritional units per acre		ELIMINATED		
Value of livestock products sold in past year .....	.20	<u>1/</u> .39	<u>1/</u> .23	1.73*
Month of purchase Dec. '66-Mar. '67	- .02	- .10	.28	- .36
Northeast	- .05	.51	.78	.66
Appalachia	- .03	.60	.57	1.04
Southeast	- .05	.02	.74	.02
Delta	- .04	- .37	1.00	- .37
Corn Belt		DUMMY BASE		
Lake States .....	.10	.10	.42	.25
N. Plains	- .17	- .39	.31	-1.24
S. Plains	- .13	- .24	.71	- .35
Mountain	- .03	-1.07	1.14	- .94
Pacific	- .04	.29	.94	.31
Bulk purchase	- .42	- .72	.25	-2.96*
Retail noncooperative .....	.10	.16	.22	.72
Retail cooperative		DUMMY BASE		
Wholesale noncooperative	- .06	- .43	.51	- .85
Wholesale cooperative .....	.07	.87	.83	1.05
Direct from manufacturer .....	.11	.40	.36	1.11
Farmer-dealer .....	.04	.67	.70	.96
Buying-group .....	.18	3.69	1.21	3.04*
Jobber-broker-contractor		DID NOT ENTER <u>2/</u>		
Discount .....	.23	.24	.18	1.37
Cash .....	.09	.09	.17	.56
Farmer delivery .....	.08	- .29	.53	- .54
Dealer delivery	- .07	- .18	.53	- .33
Custom hauler		DUMMY BASE		
Delivered to storage buildings ..	.27	.39	.51	.76
Delivered to farmstead bulk feeders	- .26	.04	.52	.08
Delivered to field bulk feeders ..		DUMMY BASE		
Distance hauled .....	.02	.00	.00	.45
Number of purchases .....	.06	.01	.00	2.85*
Number of dealers contacted .....	.04	.06	.08	.67
Number of dealers from whom purchases were made .....	.01	.06	.10	.55
Meal	- .20	- .28	.37	- .76
Crumbles .....	.11	- .21	.51	- .41
Pellets .....	.18	- .21	.35	- .60
Mixed		DUMMY BASE		
Medication .....	.03	.31	.25	1.26
Protein .....	.48	.17	.04	4.13*
Fiber	- .18	- .09	.05	-1.61
Fat .....	.15	- .11	.10	-1.07
Brand-regional .....	.06	- .03	.21	- .14
Brand-local		DUMMY BASE		
Brand-national .....	.06	.26	.21	1.20
Farm price of corn	- .16	-3.20	1.94	-1.65*

1/Scaled to farm firms with sales of \$1 million of livestock products during the preceding year. 2/No responses. *Statistically significant.

Table 13.--Regression and simple correlation results for complete feeds--poultry

Independent Variables	Coefficients for computations			
	Simple r	Regression	Standard error	T value
Weighted livestock nutritional units per acre		ELIMINATED		
Value of livestock products sold in past year	-0.24	<u>1</u> / <u>\$</u> -1.80	<u>1</u> /1.18	-1.52
Month of purchase Dec. '66-Mar. '67 .....	.14	.48	.54	.88
Northeast .....	.04	.41	.57	.72
Appalachia .....	.10	.21	.43	.49
Southeast .....	.00	.35	.60	.59
Delta	<u>2</u> /	<u>2</u> /	<u>2</u> /	<u>2</u> /
Corn Belt		DUMMY BASE		
Lake States .....	.19	.66	.40	1.65*
N. Plains	- .16	- .49	.58	- .84
S. Plains .....	.23	.22	.56	.40
Mountain	- .22	- .23	.62	- .37
Pacific	- .17	.22	.53	.42
Bulk purchases	- .26	- .06	.32	- .19
Retail noncooperative .....	.10	- .01	.28	- .03
Retail cooperative		DUMMY BASE		
Wholesale noncooperative .....	.03	.19	.45	.43
Wholesale cooperative	- .09	- .10	.56	- .19
Direct from manufacturer	- .13	- .34	.39	- .86
Farmer-dealer	- .09	- .36	.70	- .51
Buying-group	- .01	- .71	1.09	- .65
Jobber-broker-contractor	- .01	.10	.66	.15
Discount	- .11	.02	.24	.08
Cash .....	.01	.08	.22	.38
Farmer delivery .....	.30	.46	.45	1.03
Dealer delivery	- .20	- .07	.34	- .19
Custom hauler		DUMMY BASE		
Delivered to storage buildings ..	.00	.23	.61	.38
Delivered to farmstead bulk feeders .....	.01	.53	.58	.91
Delivered to field bulk feeders ..		DUMMY BASE		
Distance hauled	- .15	- .00	.00	- .61
Number of purchases	- .16	- .00	.00	- .74
Number of dealers contacted	- .04	- .01	.07	- .08
Number of dealers from whom purchases were made	- .14	.08	.30	.28
Meal	- .08	- .23	.37	- .62
Crumbles .....	.13	- .11	.42	- .26
Pellets	- .01	- .31	.45	- .69
Mixed		DUMMY BASE		
Medication .....	.19	.47	.34	1.38
Protein .....	.46	.20	.05	4.28*
Fiber .....	.02	- .00	.08	- .03
Fat .....	.04	- .10	.11	- .93
Brand-regional	- .06	- .09	.30	- .30
Brand-local		DUMMY BASE		
Brand-national .....	.14	.13	.27	.50
Farm price of corn .....	.02	.06	1.19	.05

1/Scaled to farm firms with sales of \$1 million of livestock products during the preceding year. 2/No responses. *Statistically significant.

products sold by purchaser, -0.24.

Price Difference Analysis--Supplements and Shelled Corn

Soybean meal

Two product variables--pellets and meal--were statistically significant, but their relationship to the mixed form must be interpreted because there was only one response for the mixed form. Meal was \$1.02 (SE 51¢) more than the mixed. Pellets were \$1.46 (SE 56¢) more. The more important comparison, between meal and pellets, shows that meal was 44¢ per cwt. less than the pellets.

Three service variables of statistical interest were: dealer delivery, delivery to farmstead building, and farmstead bulk feeders. Purchases delivered by dealers averaged \$1.10 (SE 59¢) more than custom haulers; deliveries to farmstead buildings and bulk feeders averaged \$2.82 (SE \$1.09); and \$2.84 (SE \$1.12) less than purchases delivered to field bulk feeders.

Size of purchaser and purchase through wholesale noncooperatives and farmer-dealers were structural variables of note. The purchaser with \$1 million livestock product sales in the preceding year averaged \$2.25 (SE \$1.18) per cwt. less than the smallest firms.

Purchases made through wholesale noncooperatives averaged 61¢ (SE 33¢) per cwt. less than those purchased through retail cooperatives. Also, purchases made through farmer-dealers averaged 86¢ (SE 46¢) less than those made through retail cooperatives.

The conduct variable with statistical import was bulk purchase. Purchases in bulk averaged 37¢ (SE 17¢) less than bagged.

The price variation associated with that in the independent variables equaled 30.2 percent. Simple r's of note were: pellets, 0.23; and purchases through farmer-dealers, -0.25.

Mixed Supplement

Product characteristics, structure, conduct, and exogenous variables all had statistically significant variables. We shall report each category's significant variables by this order of category.

Each added 1 percent of protein added an average of 3¢ (SE 0) $\frac{7}{2}$ per cwt. Pellets cost 26¢ (SE 14¢) less than the mixed form. There were 643 responses for pellets, and 111 instances of the mixed form. Meal averaged 6¢ (SE 14¢) less than mixed. There were 630 responses of meal.

Retail noncooperatives averaged 30¢ (SE 8¢) per cwt. more than retail cooperatives. Purchases by larger sized firms, those with a million dollars of livestock products sold in the preceding year, averaged 10¢ (SE 5¢) less than the smallest firms.

Purchases reported as discounted, averaged 28¢ (SE 7¢) per cwt. more than the average prices of all purchases reported without discounts. There is a plausible explanation. There were 411 purchases of bagged supplement mix which were discounted and 177 bulk purchases which also were so reported. All respondents were instructed to report their prices before subtracting the discount. They also were asked to report the absolute dollar amount of their discount and the kind of unit in which the

$\frac{7}{2}$ /Rounded to less than $\frac{1}{2}$ ¢.

Table 14.--Regression and simple correlation results for soybean meal

Independent Variables	Coefficients for computations			
	Simple r	Regression	Standard error	T value
Weighted livestock nutritional units per acre	0.03	0.04	1.21	0.03
Value of livestock products sold in past year	- .08	<u>1</u> /-2.25	<u>1</u> /1.18	-1.91*
Month of purchase Dec. '66-Mar. '67 .....	.00	.12	.30	.40
Northeast	- .07	- .03	.49	- .07
Appalachia .....	.02	.15	.43	.36
Southeast .....	.09	.62	.79	.78
Delta .....	.07	- .39	.61	- .64
Corn Belt		DUMMY BASE		
Lake States	- .06	.00	.21	.02
N. Plains .....	.00	- .01	.26	- .04
S. Plains	<u>2</u> /	<u>2</u> /	<u>2</u> /	<u>2</u> /
Mountain	- .01	.52	.46	1.13
Pacific	- .02	2.91	4.04	.72
Bulk purchase	- .18	- .37	.17	-2.18*
Retail noncooperative .....	.09	- .07	.17	- .43
Retail cooperative		DUMMY BASE		
Wholesale noncooperative	- .11	- .61	.33	-1.82*
Wholesale cooperative	- .01	.71	.73	.98
Direct from manufacturer .....	.04	.21	.38	.55
Farmer-dealer	- .25	- .86	.46	-1.86*
Buying-group	<u>2</u> /	<u>2</u> /	<u>2</u> /	<u>2</u> /
Jobber-broker-contractor	- .07	- .59	.93	- .64
Discount .....	.09	.21	.18	1.15
Cash	- .05	.08	.17	.49
Farmer delivery .....	.05	.89	.59	1.52
Dealer delivery .....	.00	1.10	.59	1.88*
Custom hauler		DUMMY BASE		
Delivered to storage buildings ..	- .03	-2.82	1.09	-2.59
Delivered to farmstead bulk feeders	- .02	-2.84	1.12	-2.55*
Delivered to field bulk feeders ..		DUMMY BASE		
Distance hauled	- .04	.00	.00	.54
Number of purchases .....	.08	.01	.01	1.35
Number dealers contacted	- .01	- .00	.00	- .02
Number dealers from whom purchases were made	- .09	- .11	.09	-1.21
Meal	- .07	1.02	.51	2.01*
Crumbles	- .06	.33	.83	.39
Pellets .....	.23	1.46	.56	2.63*
Mixed		DUMMY BASE		
Protein .....	.09	.01	.02	.67
Farm price of corn	- .01	- .22	1.63	- .13

1/Scaled to farm firms with sales of \$1 million of livestock products during the preceding year.

2/No responses.

*Statistically significant.

discount was reported--ton, cwt., etc. However, there were several responses where either the unit reported or the dollar amount was open to interpretation. Thus, no absolute dollar discounts were used in the regression. Hence, it is possible that persons who reported their prices, and who simultaneously reported their receipt of a discount, could have had prediscounted average prices that were greater than those of respondents who reported no discounts.

The factor of regionality was reflected by the individual regional differences. The numbers of responses by region also helps explain some of the differences. There were nine responses each from the Pacific and Delta regions, and 22 from the Southeast. The others all had 40 or more ranging from 44 for the Southern Plains to 780 for the Corn Belt.

The sampling size and location of the sample (such as the Missouri River weighting of the Northern Plains responses) have been discussed.

The weighted livestock nutritional units per acre correlated highly with region; for example, with the Corn Belt, $r=0.5$. Because of this relatively high correlation with region, regional location must be a major consideration in making interpretations of the regression results. The Corn Belt's prices, with 780 observations, averaged higher than those of most regions. The region with a high average price thus also happened to be a region which also had a high index of livestock nutritional units per acre. It is consistent that the Corn Belt, with a high index for livestock nutritional units in this kind of situation, also could average higher prices than regions with low index ratings. They appear to have averaged 82¢ (SE 47¢) per cwt. more. The price variation associated with that in independent variables in the model was 16.3 percent of total price variation. The simple r for protein was highest with 0.22.

Shelled Corn

The statistically significant variables included three structural, 8/ one conduct, and nine exogenous variables, eight of which were regions. Purchases from jobber-brokers-contractors averaged 23¢ (SE 9¢) less than purchases made through retail cooperatives. Purchases from wholesalers not cooperatives also averaged less than retail cooperatives by 5¢ (SE 3¢) per cwt. There was only a single purchase reported being made through a wholesale cooperative.

Bulk purchases averaged 25¢ (SE 6¢) per cwt. less than nonbulk. The respondents in counties with high livestock nutritional units per acre indexes averaged 33¢ (SE 18¢) less per cwt. than respondents in counties with low indexes. The Corn Belt dominated the shelled corn purchase responses. For all but two regions, the Corn Belt price averaged less. The Corn Belt also had one of the highest index scores.

8/While not statistically significant, the regression coefficient for the size of purchaser had an unexpected positive sign. There was high intercorrelation between size of purchaser and numbers of dealers contacted prior to purchase, and number of dealers from whom purchases were made--0.98 and 0.99, respectively. This could have lowered the statistical significance of the regression coefficient for size of purchaser. The lowered statistical significance of the coefficient could have resulted in the appearance of the incorrect sign, due to chance.

Table 15.--Regression and simple correlation results for mixed supplement

Independent Variables	Coefficients for computations			
	Simple r	Regression	Standard error	T value
Weighted livestock nutritional units per acre	0.17	0.82	0.47	1.75*
Value of livestock products sold in past year	- .03	<u>1</u> /- .10	<u>1</u> / .05	-2.18*
Month of purchase Dec. '66-Mar. '67 .....	.10	.21	.13	1.65*
Northeast	- .07	- .61	.26	-2.38*
Appalachia .....	.03	.06	.22	.27
Southeast .....	.02	.32	.32	1.03
Delta	- .05	- .51	.45	-1.12
Corn Belt		DUMMY BASE		
Lake States	- .02	- .30	.11	-2.71*
N. Plains	- .10	- .32	.11	-2.85
S. Plains	- .12	- .88	.24	-3.60*
Mountain	- .09	- .58	.22	-2.65
Pacific	- .06	- .90	.49	-1.84*
Bulk purchase	- .12	- .36	.08	-4.42*
Retail noncooperative .....	.10	.30	.08	3.72*
Retail cooperative		DUMMY BASE		
Wholesale noncooperative	- .01	- .07	.23	- .29
Wholesale cooperative	- .05	- .24	.39	- .62
Direct from manufacturer .....	.01	.21	.18	1.15
Farmer-dealer .....	.01	.14	.17	.84
Buying-group .....	.02	.61	1.29	.47
Jobber-broker-contractor .....	.03	.50	.30	1.63
Discount .....	.15	.28	.07	3.83*
Cash .....	.01	- .01	.07	- .08
Farmer delivery	- .09	- .31	.20	-1.59
Dealer delivery .....	.07	- .18	.19	- .93
Custom hauler		DUMMY BASE		
Delivered to storage buildings ..	.02	.01	.29	.04
Delivered to farmstead bulk feeders	- .02	- .08	.30	- .28
Delivered to field bulk feeders ..		DUMMY BASE		
Distance hauled .....	.03	.00	.00	1.70*
Number of purchases .....	.05	.01	2/	2.69*
Number of dealers contacted .....	.00	- .03	.03	- .92
Number of dealers from whom purchases were made .....	.04	.04	.03	1.10
Meal .....	.09	- .06	.14	- .44
Crumbles .....	.01	- .10	.20	- .49
Pellets	- .08	- .26	.14	-1.81*
Mixed		DUMMY BASE		
Protein .....	.22	.03	.00	8.08
Farm price of corn	- .10	- .29	.75	.39

1/ Scaled to farm firms with sales of \$1 million of livestock products during the preceding year.

2/ Less than $\frac{1}{2}\phi$ when rounded.

*Statistically significant.

Table 16.--Regression and simple correlation results for shelled corn

Independent Variables	Coefficients for computations			
	Simple r	Regression	Standard error	T value
Weighted livestock nutritional units per acre	-0.25	-0.33	0.18	-1.85*
Value of livestock products sold in past year	- .02	<u>1/</u> .03	<u>1/</u> .02	.55
Month of purchase Dec. '66- Mar. '67 .....	.03	.02	.03	.68
Northeast	- .09	- .11	.06	-1.72*
Appalachia .....	.33	.33	.05	6.99*
Southeast .....	.08	.32	.10	3.09*
Delta .....	.12	.53	.13	4.11*
Corn Belt		DUMMY BASE		
Lake States	- .04	.01	.04	.37
N. Plains	- .17	- .09	.04	-2.12*
S. Plains .....	.13	.28	.11	2.55*
Mountain .....	.14	.33	.09	3.70*
Pacific .....	.23	.99	.19	5.30*
Bulk purchase	- .30	- .25	.06	-4.42*
Retail noncooperative .....	.10	.05	.03	1.66*
Retail cooperative		DUMMY BASE		
Wholesale noncooperative	- .11	- .73	.15	-4.89*
Wholesale cooperative .....	.07	.21	.30	.70
Direct from manufacturer .....	.00	- .11	.17	- .67
Farmer-dealer	- .05	- .03	.04	- .89
Buying-group	- .01	- .15	.13	-1.15
Jobber-broker-contractor	- .02	- .23	.09	-2.72*
Discount .....	.00	- .08	.06	-1.26
Cash	- .04	.02	.03	.64
Farmer delivery	- .02	- .02	.05	- .38
Dealer delivery .....	.05	.04	.05	.80
Custom hauler		DUMMY BASE		
Delivered to storage buildings ..	- .03	- .16	.11	-1.44
Delivered to farmstead bulk feeders	- .02	- .18	.11	-1.62
Delivered to field bulk feeders ..		DUMMY BASE		
Distance hauled .....	.07	- .00	.00	- .91
Number of purchases .....	.04	.00	.00	.66
Number of dealers contacted	- .01	- .01	.01	-1.46
Number of dealers from whom purchases were made	- .02	.00	.01	.36

1/Scaled to farm firms with sales of \$1 million of livestock products during the preceding year.

*Statistically significant.

Regionality also displayed significant differences; that which differed most from the Corn Belt was the Pacific Region with 99¢ (SE 19¢) more per cwt.

The amount of price variation associated with that in the independent variables was 37.5 percent. The R was statistically significant at the 5-percent level. The simple r's of note included: bulk purchase, 0.30; Pacific Region, 0.23; Appalachia, 0.33; and weighted livestock nutritional units per acre, -0.25.

FREQUENCY OF APPEARANCE OF STATISTICALLY SIGNIFICANT VARIABLES

Table 17 summarizes the frequency with which specific kinds of variables appeared with statistical significance, compared with the total number of times they could have appeared with such significance. Thus, in the case of complete feeds, there were 28 product characteristic variables, each of which could have been statistically significant. About 29 percent of the total actually were. For supplements, the corresponding percentage was 25, and for all feeds studied, about 27 percent. For all feeds, about 18 percent of the total market structure variables were statistically significant, about 20 percent of the conduct, and 24 percent of the exogenous.

Table 17.--Relative frequency with which variables within specified categories appeared with statistical significance, by type of product

Variables and significance	Unit column	Product attributes	Market structure	Market conduct	Services	Exogenous factors	Total
Complete feeds:							
Total that could have been	No.	<u>1</u> / 28	40	32	28	52	180
Percentage that was	Pct.	28.6	12.5	15.6	3.6	11.5	13.9
Supplements:							
Total that could have been	No.	16	40	10	14	26	106
Percentage that was	Pct.	25.0	17.5	30.0	21.4	30.8	23.4
Shelled corn:							
Total that could have been	No.	n.a.	10	8	7	12	37
Percentage that was	Pct.	n.a.	40.0	12.5	0	66.7	35.0
Total:							
Total that could have been	No.	44	90	50	49	90	323
Percentage that was	Pct.	27.3	17.8	19.1	8.2	24.4	19.5

1/There were 7 product characteristic variables for each of the four complete feeds tested. If each had been statistically significant there would have been 28, etc.

In other terms, of the total 180 variables tested for the complete feeds, nearly 14 percent were significant. Of the 106 tested for the supplements, 23 percent were, and for shelled corn, 35 percent of the 37 variables tested were significant. Of the total 323 tested variables, nearly 20 percent were statistically significant.

ADDITIONAL MODEL COMPARISONS

Model Alterations

The basic model just discussed was altered to make additional comparisons. One set, Model A, involved using only those variables from the basic model which had entered as significant, or which remained significant after the last step had been computed. Model B was the same as the basic model, except all regional location was eliminated. Model B was used only for the complete feeds.

Results

The regression coefficients in all models were sufficiently similar so that those for Models A and B are not reported. The comparison of the coefficients of determination in table 18 provides some basis for broader evaluation.

Table 18.--Comparisons of multiple coefficients of determination for basic model, and models A and B

Model	Complete feeds				Supplements		Shelled corn
	Dairy	Beef	Hog	Poultry	Soybean meal	Mix	
Basic	0.29	0.35	0.47	0.54	0.30	0.16	0.37
A	.28	.30	.44	.47	.19	.15	.36
B	.25	.30	.45	.50	--	--	--

Model A, when compared with the basic model, suggested that the range of variation which could be associated with the numbers of variables included in the model's application, ranged from 1-percent for supplement mix, complete dairy feed, and shelled corn, to 11-percent for soybean meal. Overall, the model was not affected as much by the use of the 46 independent variables as it might have been. Comparisons of the basic model with Model B, for complete feeds, showed that except for the complete dairy feed, regionality was not statistically significant as an entity. The test for overall regionality was not made for supplement mix. The results for it suggest that for this item regionality as an aggregate might also have significance.

INTERPRETATION OF RESULTS

Some Cautions

Companies vary with respect to the kinds, numbers, and the quality of services which they provide with the sale of their products. This study made no attempt to enumerate or evaluate all of such services. Thus, price differences observed are gross, not net differences. In the case of bagged feeds, no allowances for bag return were made.

The sampling procedure, which was directed primarily at obtaining reports of pesticide use, gave substantial weight to land segments along the Missouri River, particularly in the Northern Plains Region. In other regions, the number of respondents were few enough so that the inclusion of a few really large operations could

have affected the results for these regions; The Mountain Region was one.

There was no differentiation among feeds for the kinds of ingredients used as sources for energy and protein. Specifically, no differentiation was made between animal and vegetable fats and proteins.

There also is the possibility that some of the purchases reported as being made through wholesale sources actually more closely approximated discounted retail prices than true wholesale prices.

High intercorrelations were found among several of the independent variables. Results must be interpreted with this in mind. However, the overall stability of the results, and the fact that the nontime-series character of the study minimized both autocorrelation and serial correlation, also should be recognized.

Finally, the use of the comparisons of averages should be made with the understanding these are regression coefficients, and that as is the case for all such coefficients, these averages are within the contest that all other variables were held constant.

Conclusions

With these cautions in mind, the following conclusions may be drawn:

1. The large-scale operator with \$1 million or more of livestock sales a year enjoyed favorable price differentials. Some were small and without statistical significance, but some, like soybean meal, were substantial and statistically significant.
2. Source of purchase made a difference in the level of price that was quoted. Purchases made through any single source did not always yield price benefits to the purchaser. Thus, of the 38 comparisons made, 22 times the average prices of purchases made through wholesalers were less than the average prices of purchases made through retail cooperatives, but 16 times they were higher. Of the seven product comparisons between retail noncooperatives and retail cooperatives, in 5 cases the average prices of purchases made through retail noncooperatives were higher, but in two instances, they were lower. In some cases, the amount of difference between the two averages was substantial. In others, it wasn't. For example, for complete feeds for dairy farms, purchases made through jobber-broker-contractors averaged 74¢ per cwt. less than the average price of purchases made through retail cooperatives, but farmer-dealers averaged only 2¢ per cwt. less, and this 2¢ differential was not statistically significant. Average prices for farmer-dealers in other cases, were substantially higher. In other instances, the jobber-broker-contractors also averaged higher than the retail cooperatives, and by a substantial amount.
3. Prices reflecting proximity to production regions, and the availability to barge transport tended to be lower than adjacent regions. For instance, prices in the Northern Plains Region were lower than in the Corn Belt.
4. Producers paid significantly for each added percentage of protein. Thus, growers should avoid waste by employing efficient feeding procedures, particularly for high-protein feeds. They should also choose feeding formulas most appropriate for their feeding needs. There is no single formula that is most appropriate for all growers, activities, or occasions.

5. Bulk purchasing saved substantial amounts. For complete feeds, bulk purchases saved 6¢ to 72¢ per cwt., and averaged about 33¢ less than bagged purchases. For supplements they averaged about 37¢, and for shelled corn, 25¢ per cwt., less.
6. The number of dealers contacted prior to their last purchase averaged fewer than 2, except for shelled corn and soybean meal. Shelled corn averaged 2, and soybean meal 7.3 contacts. The regression coefficients in each instance were not statistically significant. In the case of shelled corn they averaged 1¢ per cwt. lower for each contact made. However, the regression coefficient was not statistically significant.
7. Discounts were provided, but prices cited prior to the deduction of the discount averaged higher than the average prices reported by respondents not reporting discounts received. The average discounted price possibly was lower, but the data did not provide a basis for making such a computation.
8. Brand differences were statistically significant only for complete dairy feeds. Here national brands averaged 33¢ (SE 9¢) more per cwt. than local brands, other variables being held constant. Regional brands, also for complete dairy feeds, averaged 6¢ (SE 7¢) less, but this coefficient was not statistically significant. Comparative services rendered by each type of dealers are not known.

For the other complete feeds, regional brands averaged nearly 9¢ per cwt. less than local brands. In no instance was the regression coefficient statistically significant. The national brands averaged 6¢ per cwt. less than local brands for complete beef feeds, but 26¢ higher for hog feeds, and 13¢ higher for poultry. Again, the regression coefficients were not statistically significant.

APPENDIX 9/

Sampling procedure in detail

Because no complete list of farms (universe) was available from which to sample, the area frame sampling technique was used. This approach meets the requirements of a probability sample because each farm operator in the universe had a known chance of greater than zero of being selected. Counties were grouped into agriculturally similar, contiguous groups. Emphasis in grouping focused upon crops such as fruit, vegetable, poultry, dairy, tobacco, and alfalfa, and relied upon units of production and value of sales for grouping purposes. Of course, size of grouping depended upon the number of qualifying farms, density of farms, and area of the county. The group usually consisted of counties containing about 4,000 farms. Naturally, in desert or mountainous regions farm numbers per group were much lower. In some instances, farm grouping crossed State lines, but they never were permitted to cross the boundaries of the 10 ERS Farm Production Regions: Northeast, Appalachian, Southeast, Delta, Corn Belt, Lake States, N. Plains, S. Plains, Mountain, Pacific.

Adoption of this procedure produced 397 groups in the 48 contiguous States. From each of these groups, one county was selected with a probability proportional to the number of qualifying farms within the county. Survey results cover only farmsteads in open country and with special emphasis upon farms with \$10,000 of sales or above. Thus, the county with the largest number had the greatest probability for selection. But, because the selection procedure was random, even the county with the fewest qualifying farms could be chosen. Exceptions to the use of single counties occurred

when the county's number of qualifying farms was small relative to the total number of farms within the county. In such instances, two or more contiguous counties were aggregated into a single selection unit. The sample chosen yielded 417 counties.

The master sample, developed at Iowa State University (jointly with the Bureau of Agricultural Economics and Agricultural Census, 1943-45), was used to select smaller land elements, called "segments", from within the selected counties.

The land area of the United States was divided into three strata based upon incorporation and density of population. These strata were designated "incorporated" (cities and towns that are incorporated), "unincorporated" (areas of fairly dense population, but not incorporated), and "open country" (the remaining land area). This summary discussion limits itself to the open country, as for this study, open country is by far the most important. Open country covers 96 percent of the total land area.

Once the strata were defined, we located them on general highway and transportation maps of each of the counties of the 48 contiguous States. These maps showed the location of farmsteads and other dwellings with varying degrees of accuracy. We used these indications as a measure of size for determining the number of sampling units to be assigned a given area, and to control the size in terms of indicated farms and dwellings of each. Each county was broken up into sub-areas, called count units. A count unit was defined as "an area with a natural boundary except where minor civil division boundaries were used and which included a minimum of six farms or eight dwellings, and a maximum of about thirty farms." For each count unit, the number of farms and the total number of dwellings (including farms) were marked on the map within the count unit area. These count units were made for all open country areas.

The next step determined the number of sampling units, or segments, to be assigned to each count unit on the basis of the count unit information. Consideration was given to the problem of finding identifiable boundaries for small areas and to the region of the country. Each segment contained from two to 10 farms. In terms of area, the segments in the master sample averaged $2\frac{1}{2}$ square miles, or 1,600 acres, in size, but varied according to location and other circumstances. The number of segments was entered on the map along with the number of farms but the segment boundaries were not entered. Here is where the sampling for this study actually started. To obtain the desired precision for the survey, it was determined we needed about a 1-percent sample of all qualifying farms. This meant that for a selected county, we required a 1-percent sample of the number of qualifying farms in the county's grouping. Both the number of qualifying farms in the county, and in the group, and the number of master sample segments in the county were available. These were all the necessary ingredients to compute a within-county sampling interval.

The sample segments were drawn from an accumulated listing for segments using a random start between one and an interval derived for the county, and then successively applying the interval. The procedure for deriving the interval is illustrated below for Jones and Fayette Counties, Iowa. The procedure would yield either 17 or 18 segments in Jones County and either 18 or 19 segments in Fayette County, depending upon the random start.

Example:

	<u>IOWA</u>	
	<u>Jones County</u>	<u>Fayette County</u>
1959 census qualifying farms)	1,425	1,898
1959 census qualifying farms) for the group from which the county was selected)	4,495	4,559
Master sample segments in) the county)	563	771
Sampling rate needed to get) the desired number of farms)	$\frac{(.01) (4495)}{1425} = .0315$	$\frac{(.01) (4559)}{1898} = .0240$
Number of segments required) to get the farms desired ...)	$(.0315) (563) = 17.73$	$(.0240) (771) = 18.50$
Sampling interval)	$\frac{563}{17.73} = 31.8$	$\frac{771}{18.5} = 41.7$

For the survey, an enumerator was expected to work about one county during the survey period. Therefore, restricting the number of qualifying farms in a grouping of counties to about 4,000 provided a reasonable number of segments per county for each enumerator.

The number of questionnaires obtained from qualifying farms was below the expectation in the 1964 survey. If our procedure had qualified farms in the same way as the census did, this 1-percent sample should have resulted in about 15,000 questionnaires. The census determined gross value of sales by detailed questioning and editing to adjust for inventory changes. The 1964 Pesticide Survey questionnaire asked for gross sales of agricultural products directly with no detailed breakdown of sales for inventory adjustments.

The 1959 census data were used to give a measure of size, without danger of bias. This measure of size was used to set up strata and give a distribution of segments, to improve the sample design over what we could have obtained with simple random sampling of segments. Estimates from the sample were computed, using the sampling fraction of segments and this was entirely independent of historic data. In 1966, the following adjustments were made:

- (1) A new segment was selected by a rule of association to replace each 1964 segment. The rule of association located a new segment adjacent to or near the 1964 segment. This saved money.
- (2) Three-quarter's of the new segments, randomly selected, interviews were obtained from all resident farm operators who had a gross value of sales of \$10,000 or more in 1966.
- (3) In the remaining fourth of the segments, interviews were obtained from all resident farm operators.

- (4) In addition, enumerators returned to all 1964 segments that contained an operator whose gross value of sales was \$20,000 or more in 1964. Each such operator was questioned to determine if his gross value of sales in 1966 was \$40,000 or more. If so, a complete schedule was sought. The effect was to screen all 1964 segments for large operators.